RELATIONSHIP OF EMG ACTIVATION AND EEG ACTIVITY WITH SHOOTING ACCURACY AND THROWING VELOCITY IN HANDBALL

A research synopsis

Submitted for the fulfilment of requirement of the degree of

DOCTOR OF PHILOSPHY

TO

Lakshmibai National Institute Of Physical Education , Gwalior

By
Preeti Yadav

Under the supervision of
Dr. Ashish Phulkar
Associate Professor, LNIPE Gwalior

DEPARTMENT OF SPORTS MANAGEMENT
LAKSMIBAI NATIONAL INSTITUTE OF PHYSICAL EDUCATION, GWALIOR

TABLE OF CONTENT

1)CHAPTER -I - Introduction

a) Brief introduction of the topic

b) Statement of the problem

c) Research Question

d) Objective of the study

e) Hypothesis

f) Delimitation

g) Limitation

h) Definition and explanation of the term

i) Significance of the study

2) CHAPTER -II - Review of related literature

3) CHAPTER -III - Research Methodology

a) Selection of subjects

b) Selection of tests with justification

c) Administration of tests and collection of data

d) Statistical techniques employed in the study

4)REFERENCES

INTRODUCTION

Handball is an Olympic team sport that requires muscular strength, power, speed, and endurance (González-Ravé et al., 2014). Although it is basically a throwing sport, the most important feature of handball that distinguishes it from other throwing sports concerning throwing is that the ball is thrown by hand with many different forms and variations. As the final aim of the handball game is to score more times than the opponent, throwing performance and technique seem to be major key skills for success in competitive handball, with the effectiveness of a shot primarily affected by two factors: throwing velocity and accuracy. It is a fact that an athlete who plays handball at a high level should attach importance to the development of the upper extremity and it should not be ignored. Hence, during the handball competition that requires a high level of endurance, the strength parameter also gains importance to minimise the effects on throwing technique and mechanics (Zapartidis *et al.,* 2007; Chaouachi *et al.,* 2009).

One of the methods of measuring muscle torque and power is isokinetic dynamometry. Isokinetic measurements are used in the sports literature because they produce highly objective data and focus only on the muscle group being measured during the test (Xaverova *et al.,* 2015; Bonetti *et al.,* 2019). The shoulder internal-external rotator (IRER) muscles have been investigated in many studies because they are important for providing joint stability. Since the role of the shoulder IR-ER muscle group is significant in high ball throwing speed in handball, it seems important to investigate it in handball players.(González-Ravé et al., 2014)

It is known that electromyography (EMG) measurements are frequently used to determine the level of muscle activation in terms of quantity (number) in sportive activities (Rousanoglou *et al.,* 2015). It is observed that studies using EMG are

mostly carried out to determine the contraction strength of muscles. The determination of the activation levels of the muscles in the shoulder girdle (throwing arm side) while throwing in handball, as well as the association of the data obtained as a result of the isokinetic strength measurement with the shooting accuracy appear to be a subject that has not been addressed comprehensively in the handball literature.

One of the most common tools in assessing brain function when learning and performing motor skills is electroencephalography or EEG. EEG is a non-invasive technique for measuring electrical currents generated from active areas of the brain, the amount of activity of which can be determined by the strength of the EEG signal (Whittier 2017). Also, different patterns of EEG can be seen at different frequencies of delta (less than 4 Hz), theta (4–8 Hz), alpha (8–12 Hz) and beta (13–30 Hz) during skill preparation and execution.

And these patterns can be closely related to individual behavior.(Khanjari et al., 2023)

Handball is a demanding sport that requires precise shooting accuracy and high throwing velocity. Understanding the underlying factors that contribute to these performance measures can provide valuable insights for training and performance enhancement. This research aims to investigate the relationship between peak torque ratio, electromyographic (EMG) activation, and electroencephalographic (EEG) activity with shooting accuracy and throwing velocity in handball players. It is expected that this research will provide valuable insights into the physiological and neural factors influencing shooting accuracy and throwing velocity in handball players. The findings may contribute to the development of more effective training protocols, injury prevention strategies, and performance enhancement techniques tailored to the specific needs of handball players.

STATEMENT OF THE PROBLEM

This study will attempt to analyse relationship between EMG activation and EEG activity with shooting accuracy and throwing velocity in handball players.

RESEARCH QUESTION

Is there any Relationship Between EMG Activation, EEG Activity, and Shooting Accuracy and Throwing Velocity in Handball Players

OBJECTIVES OF THE STUDY

The objectives of the study are:

1. To analyze the relationship between EMG (Electromyography) activation of key upper limb muscles and shooting accuracy in handball.
2. To examine the association between EEG (Electroencephalography) brain activity patterns and throwing velocity during handball performance.
3. To study the neuromuscular and cognitive demands of shooting in handball under real field (court) conditions.

4. To provide evidence-based recommendations for training interventions aimed at improving shooting accuracy and throwing speed through neuromuscular and cognitive monitoring.

SIGNIFICANCE OF THE STUDY

1.This research has the potential to contribute to the scientific understanding of the factors influencing shooting accuracy and throwing velocity in handball players.

2.The findings may inform training programs, rehabilitation strategies, and skill development interventions for handball athletes.

3.Additionally, the study may provide insights applicable to other sports involving precision throwing actions.

4.By investigating the relationships between EMG activation, EEG activity, shooting accuracy, and throwing velocity in handball players, this study aims to enhance our understanding of the biomechanical, neuromuscular, and neurophysiological aspects underlying these performance measures.

5.The findings could have implications for optimizing training methods and improving overall performance in handball and potentially other related sports.

6. Bridges neuroscience and sports performance:
The study integrates EMG and EEG technologies to understand how brain and muscle activity influence key handball skills.

7. Enhances training strategies:
Insights from neuromuscular and cognitive data can help coaches develop personalized drills to improve shooting accuracy and throwing power.

8. Supports mental conditioning:
EEG findings related to focus and motor planning may inform cognitive training and mental preparation techniques for athletes.

HYPOTHESIS OF THE STUDY

On the basis of literature reviewed, available research findings, expert opinions, and researcher's own understanding of the problem , it is hypothesized that :

H_0: There will be no significant relationship between EMG activation ,EEG activity and handball shooting accuracy and throwing velocity.

H_1: There will be significant relationship between EMG activation , EEG activity on handball shooting accuracy and throwing velocity.

DELIMITATION OF THE STUDY

Since the study will be conceptualized with a very specific purpose for selected handball players in lieu of having a better understanding of the relationship between selected variables, the researcher has confined the study within the following area:

1. The study will be delimited to 25 handball players of inter university level.
2. The study will be further delimited to players within the age bracket of 187-25 years .
3. The study will be further delimited to players who have a minimum training age of 2+ years .

LIMITATION

1.researcher cannot control the environmental condition during EEG waves measurement, which can act as artifact in it.

2. it cannot identify the effect of power generated by lower limb in throwing /shooting actions.

3. researcher also cannot control the participants motivation levels and effort during testing .

OPERATIONAL DEFINITION OF TERMS

PEAK TORQUE RATIO: the measurement of maximal muscular strength against a resistance in single contraction.

ELECTROMYOGRAPHY: recording of electrical activity of muscles

EEG ACTIVITY : a test that measures electrical activity in the brain cell using small , metal discs (electrodes) to the scalp.

MUSCLE ACTIVATION : muscle ability to switch on and work .

RMS : rot square mean value . represent the square root of the average power of the EMG signal for a given period of time.

ARV : average rectified value . time windowed mean of the absolute value of the signal .

Frequency band : EEG measures brainwaves of different frequencies within the brain. Electrodes are placed on specific sites on scalp to detect and record electrical impulses within the brain.

CHAPTER II

REVIEW OF RELATED LITERATURE

S . No.	Year of publication	Title	Authors	results
1	2023	The simultaneous changes in motor performance and EEG patterns in beta band during learning dart throwing skill in dominant and non- dominant hand	Yaser khanjari, elahe arabameri , mehdi shahbazi	With skill learning , constant changes in EEG activity pattern occur, so concept of motor learning is visible at brain level.
2	2021	Effect of isokinetic shoulder performance electromyographic activation and throwing velocity on shooting accuracy in elite male handball players	Yucel MAKARACI, Syedi Ahmet AGAOGLU	Shooting peak torque have an adverse effect on shooting accuracy . no relationship between muscular activation, throwing velocity and shooting accuracy was found
3	2021	Quantitative EEG in sports: performance level estimation of professional female soccer Players	Kittichai Tharawadeepimuk and Yodchanan Wongsawat	quick perceptual response to an acute bout of brain activity could predict an athlete's performance during competition

4	2008	Changes in EEG during graded exercise on a recumbent cycle ergometer	Stephen P. Bailey , Eric E. Hall , Stephen E. Folger and Paul C. Miller	The results of this investigation demonstrate that brain activity may be related to exercise intensity.
5	2014	Shoulder muscle dynamometry characteristics : side asymmetry and correlations with ball throwing speed in adolescent handball players	Inese pontaga, Janis zidens	Positive correlation with PT and ball throwing speed.

CHAPTER III

SELECTION OF THE SUBJECTS

25 skilled handball male and female players with a minimum of 2 years of training age will be purposively selected. Players will be of inter university level of age group 18-25 years.

SELECTION OF TEST WITH JUSTIFICATION

Instruments and Tools

1. **Wireless Surface EMG System**
    - To record muscle activation in key upper limb muscles (e.g., deltoid, triceps, forearm muscles).
    - Attached using surface electrodes; signals recorded during throwing actions.
2. **Portable EEG Headset**
    - To monitor brain activity (alpha and beta waves) related to focus and motor planning.
    - Worn comfortably during performance; captures frontal and motor cortex activity.
3. **Radar Gun or Ball Speed Sensor**
    - Used to measure throwing velocity in kilometers per hour (km/h).
    - Positioned behind the goalpost to detect the speed of each throw.
4. **ZEIN BATTERY TEST**
    - Used to record and evaluate shooting accuracy.

- A target sheet with scoring zones is placed on the goal.

Administration of the Test

1. Preparation:
   - Participants report to the handball court, and informed consent is obtained.
   - EMG electrodes and EEG headset are properly fitted and tested for signal quality.
   - Players undergo a standard warm-up.
2. Testing Procedure:
   - Each participant performs 10–15 throws from the 9-meter mark, aiming at the target board.
   - EMG and EEG data are recorded simultaneously during each throw.
   - Throwing velocity is measured using the radar gun.
   - Shooting accuracy is recorded by zein battery test.
3. Post-Test:
   - Devices are safely removed; players are debriefed.
   - Data is collected, labeled, and prepared for statistical analysis.

STATISTICAL TECHNIQUE

1. **Descriptive Statistics**
   - **Mean, standard deviation, minimum, and maximum values** will be calculated for all variables including EMG activation, EEG activity, shooting accuracy, and throwing velocity.

- This helps summarize the overall performance and physiological responses of the participants.

2. **Pearson's Correlation Coefficient**
    - Used to assess the **strength and direction of the relationship** between:
        - EMG activation and throwing velocity
        - EEG activity and shooting accuracy
    - Helps determine whether increased muscle or brain activity is associated with better performance.
3. **Linear Regression Analysis**
    - Used to **predict performance outcomes** (accuracy and velocity) based on EMG and EEG values.
    - This will show how much variance in performance can be explained by neuromuscular and cognitive activity.
4. **Significance Level**
    - A **p-value < 0.05** will be considered statistically significant to determine meaningful relationships.

REFERENCES

1, González-Ravé, J. M., Juárez, D., Rubio-Arias, J. A., Clemente-Suarez, V. J., Martinez-Valencia, M. A., & Abian-Vicen, J. (2014). Isokinetic Leg Strength and Power in Elite Handball Players. *Journal of Human Kinetics*, *41*(1), 227–233. https://doi.org/10.2478/hukin-2014-0050

Khanjari, Y., Arabameri, E., Shahbazi, M., Tahmasebi, S., Bahrami, F., & Mobaien, A. (2023).

2. learning dart throwing skill in dominant and non-dominant hand. *Computer Methods in Biomechanics and Biomedical Engineering*, *26*(2), 127–137. https://doi.org/10.1080/10255842.2022.2048375 GARCÍA, J.A.; SABIDO, R.; BARBADO, D. & MORENO F.J. (2013).

3.Analysis of the relation between throwing speed and throwing accuracy in team-handball according to instruction. *European Journal of Sport Science,* 13(2): 149-154. GHOSH, P. & MONDAL, P. (2017).

4. on kinematics parameters of jump shot in handball.
International Journal of Physical Education, Sports and Health, 4(4): 453-456.
HADDAD, M.; PRINCE, M.S.; ZARROUK, N.; TABBEN, M.; BEHM, D.G., & CHAMARI, K. (2019).

5.Dynamic stretching alone can impair slower velocity isokinetic performance of young male handball players for at least 24 hours. *PLoS ONE*, 14(1): e0210318. doi.org/10.1371/journal. pone.0210318. HERMASSI, S.; CHELLY, M.S.; BRAGAZZI, N.L.; SHEPHARD, R.J. & SCHWESIG, R. (2019).

6. In- Season weightlifting training exercise in healthy male handball players: Effects on body

composition, muscle volume, maximal strength, and ball-throwing velocity. *International Journal*
of Environmental Research and Public Health, 16(22): 4520 (pp. 14). doi.10.3390/ijerph16224520.
HERMENS, H.J.; FRERIKS, B.; DISSELHORST-KLUG, C. & RAU, G. (2000).

7.Development of recommendations for SEMG sensors and sensor placement procedures. *Journal of Electromyography and Kinesiology*, 10(5): 361-374. KHALED, B.; HAKIM, L.; ABDELKADER, B. & AMINE, S. (2018).

8. The impact of proposed exercises in the method of plyometric training in the development of explosive power and some basic skills of handball category (U17). *European Journal of Physical Education and Sport Science,* 3(12): 629-639. LAFFAYE, G.; DEBANNE, T. & CHOUKOU, M.A. (2012).

9.Is the ball velocity dependent on expertise? A multi-dimensional study in handball. *International Journal of Performance Analysis in Sport*,
12(3): 629-642.
MASCARIN, N.C.; VANCINI, R.L.; LIRA, C.A. & ANDRADE, M.S. (2015).

10.Stretch-induced reductions in throwing performance are attenuated by warm-up before exercise. *The Journal of Strength & Conditioning Research*, 29(5): 1393-1398. doi.10.1519/JSC.0000000000000752.
MAKARACI, Y. (2021).

11.The concept and importance of throwing velocity in handball. A systematic
review. *Gazi Journal of Physical Education and Sport Sciences,* 26(1): 45 – 58.
ORTEGA-BECERRA, M.; PAREJA-BLANCO, F.; JIMÉNEZ-REYES, P.; CUADRADO-PEÑAFIEL, V. & GONZÁLEZ-BADILLO, J.J. (2018).

12. Determinant factors of physical performance and specific throwing in handball players of different ages. *Journal of Strength and Conditioning Research*, 32(6): 1778-1786. PLUMMER, H.A. & OLIVER, G.D. (2017).

13.The effects of localised fatigue on upper extremity jump shot kinematics and kinetics in team handball. *Journal of Sports Sciences*, 35(2): 182-188. PONTAGA, I. & ZIDENS, J. (2014).

14. Shoulder rotator muscle dynamometry characteristics: Side asymmetry and correlations with ball-throwing speed in adolescent handball players. *Journal of Human Kinetics*, 42(1): 41-50. Neural changes induced by learning a challenging perceptual- motor task. Neuroimage. 41(4):1395–1407. Ito M. 2002.

15. Historical review of the significance of the cerebellum and the role of Purkinje cells in motor learning.Ann N Y Acad Sci. 978(1):273–288. Kiefer AW, Cremades JG, GD. 2014.

16. Train the brain: novel electroencephalography data indicate links between motor learning and brain adaptations. J Novel Physiotherapies. 4(2)